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ASTRONOMICAL PROBLEMS OF TO-DAY[1]

By Sir JAMES JEANS, F.R.S.

PROFESSOR OF ASTRONOMY, THE ROYAL INSTITUTION

THIS evening I propose to discuss a group of problems relating to the central problem of the structure of the universe. No final or definite answers have yet been found for these, so that we shall be discussing questions rather than answers.

The earliest astronomy was geocentric, the earth being supposed to be the center of the whole universe. This view was not based on astronomical evidence but had its roots in man's self-esteem, in his want of imagination and in the meagerness of his scientific knowledge. It met its end in the arguments of Copernicus and in the observations of Galileo.

It was succeeded by what we may call a heliocentric astronomy, in which the sun was supposed to be at or near the center of the galactic system and possibly also of the whole universe. This view did not result from any human frailty; there seemed to be good scientific evidence for it.

For a superficial study of the sky shows that those stars that appear brightest to us, and so are presumably nearest to us, are scattered fairly uniformly in the different directions of space, while the Milky Way divides the sky into exactly equal halves and itself looks about equally bright in all its parts. All this seemed to indicate a disc-shaped system of stars, with the sun lying in the central plane of the disc and fairly close to its center. Such a view of the structure of the galaxy appeared to find confirmation in the pioneer researches of the two Herschels and in the later investigations of Kapteyn, Seares and others.

We know now that it was entirely wrong. It was wrong because these investigators had assumed that space was entirely transparent to light. We know now that the whole galactic system is permeated by a patchy fog of obscuring matter, which is not dense enough to affect the light of the nearer stars appreciably but blots out the more distant stars entirely. This fog makes the greater part of the galactic system

[1] Abstract of lecture before the Royal Institution of Great Britain, March 26, 1943.

invisible to us; if our predecessors thought they were at the center of the galactic system, it was as a man who is in a forest in a thick fog may think he is at the center of the forest, although in truth he is only at the center of the small group of trees he can see through the fog.

We know now that the center of the galaxy is far removed from the sun and that the sun, like all the rest of the galaxy, is revolving round this distant center. Observation shows that the sun's period of rotation is about 250 million years and that its orbital speed is of the order of 270 kms. a second. These purely observational data show that the galactic center must be at a distance of about 36,000 light-years from the sun.

It used to be thought that our own particular galaxy was far larger than any other in the sky, but it is now clear that all galaxies are very similar in size and also very similar in mass. Our own galactic system can be weighed by calculating the gravitational force it exerts on the sun to keep this moving in the orbit already described; the requisite mass comes out at about 150,000 million suns. It is also possible to weigh a close pair or cluster of galaxies by calculating the gravitational force they must exert on one another so as to prevent the more rapidly moving members running away into space. The average mass needed usually comes out at about that just mentioned for our own galaxy, most estimates ranging from 95,000 million to 200,000 million suns. On the evidence at present available the galaxies seem likely to differ far less one from another than the stars of which they are composed, and we are led to picture the astronomical universe as consisting of a number of similar units—our own galaxy and the other galaxies—rather like the molecules of a gas.

On pointing a telescope in different directions in space we see fields of stars which differ greatly from one another, a consequence of the finite size and definite structure of the galaxy. No comparable variations are to be found in the fields of galaxies seen in different directions in space. Clusters may be seen here and there, also bare patches in places, but broadly speaking the galaxies seem to be scattered fairly evenly through space, the average distance of neighbors being something over a million light-years. We do not know whether this uniformity of distribution persists through the whole space or not, for the galaxies that we can see may perhaps form only a small part of some grander system, built on such a scale that no appreciable difference of structure occurs within the distances accessible to our telescopes.

If, however, the distribution is uniform through the whole of space, then space must be finite; otherwise it would contain an infinite amount of matter and the gravitational force from this would be infinite, which is contrary to the fact. This alternative, then, brings us to the type of universe which Einstein contemplated in his original relativity theory. Space is curved with a positive curvature—like the surface of the earth—and is filled with matter of which the average density is everywhere the same. On this theory the size of space is determined uniquely by the average density of matter, much as the size of an expanded balloon depends on the density, and so on the pressure, of the gas inside it. From the data already mentioned, we can deduce that the average density of matter in space must be of the order to 10^{-28} gms. per cu.cm., or about one atom to the cubic yard. With this density the radius of space must be about 3,300 million light-years—at least if the whole structure is at rest in a configuration of equilibrium. Thus the whole range of our biggest telescopes would be only a minute fraction of the size of space.

This seemed to provide a possible and consistent scheme until Friedmann and Lemaître showed that such a universe could not stand at rest in equilibrium. It would be unstable in the sense that space itself would have to start either expanding or contracting. Some time after this, Hubble and Humason found displacements in the spectra of distant nebulae which, interpreted in the simplest way as Doppler effects, showed that the distant nebulae were all receding from us and suggested that space might actually be expanding just as Friedmann and Lamaître had predicted. Observation showed that the rate of expansion would be the same everywhere and such that, if it were maintained at its present value, the linear dimensions of space would be doubled in about 1,800 million years.

This in turn suggested that the universe might have started as an Einstein universe of the kind already described and that the inherent instability of such a configuration had caused it to expand to its present dimensions. But the theory of relativity could not deduce the present dimensions, either from the present density of matter or otherwise, Einstein's relation between size and density referring only to a universe at rest in equilibrium.

Eddington has claimed to solve the problem by quite different methods. In brief he believes that the total number of protons in the universe must be 136×2^{256}, there being also an equal number of electrons; he has produced arguments to show that there can not, from the nature of things, be anything other than this.

Knowing the number of particles in the universe and the mass of each, it is easy to calculate the total mass of the universe, and hence the dimensions, since we already know the average density to be about 10^{-28}

he radius of curvature comes out at some 2,000 or ,000 millions of light-years. But if the universe tarted as an Einstein universe in equilibrium, then he total mass it contained—the known total mass of ll Eddington's particles—would fix its curvature defiitely and precisely. Eddington calculates that the adius of curvature would then be 1,068 millions of ght-years. Thus the expansion of the universe up o the present can only have increased its dimensions ome two or three fold, a process which would occupy nly a few thousands of millions of years. This agrees ell enough with what we know as to the age of the arth, for it seems probable that the earth came into xistence between 2,000 and 3,000 millions of years go, the sun then being at the very beginnings of its xistences as a star. It also agrees with what we know s to the ages of the stars; if present conjectures as o the mechanism of stellar radiation are right, the tars can hardly have contained available energy to rovide radiation for more than a very few thousands f millions of years.

The problem has been attacked on different lines by Milne, Dirac and others. After the geocentric and the heliocentric universes had been banished from astronmy, the apparent recessions of the nebulae seemed o suggest a galacto-centric universe, with our own alaxy as the center from which all others were movng radially away. Milne based his theory on what he escribed as the "cosmological principle"—the universe is not in any way centered in our galaxy; this ccupies no specially favored position, so that the picture which an inhabitant of our galaxy draws of the large-scale features of the universe would be equally valid for any other galaxy.

With the help of this principle Milne draws a picture which seems at first sight to describe something totally different from the expanding universe of Friedmann and Lamaître. But Kermack and McCrea claim to have shown that the two pictures differ only in the way in which two maps of the same country differ when they are drawn on different projections—if we compare the relativity picture to a spherical projection, then Milne's picture may be compared to a Mercator projection. McVittie has recently claimed that Milne's results do not really depend on the cosmological principle at all, but can all be deduced from assumptions which Milne has unwittingly introduced under an erroneous impression that they are axiomatic. But all this is still under discussion.

Another line of investigation was opened by Dirac, possibly under the influence of a remark which Eddington made as far back as 1923.

Physics provides a natural unit of force, namely, the attraction between the nucleus and the electron in the hydrogen atom. Astronomy also provides a natural unit of force—the force with which the same two particles attract one another gravitationally. This latter unit is very small in comparison with the physical unit, the two standing in the ratio of 1 to 2.3×10^{39}. This is of course a pure number and so is independent of the particular units we use for our measurements. We have already mentioned another large number—the number of protons in the universe, which Eddington claims must be 1.57×10^{79}. The square root of this number is 3.9×10^{39} and so is very close to the ratio of the electric and gravitational forces just mentioned. Eddington and Dirac have both suggested that the agreement is too good to be the result of a mere coincidence; they prefer to think that it must result from some fundamental property of the universe.

Again physics provides a natural unit of time. It can be expressed in a variety of forms, the simplest being that it is the time light takes to travel across the diameter of an electron, about 1.25×10^{-23} secs. Astronomy also provides a natural unit of time; it is the fictitious time that the various galaxies would take to reach their present positions if they had all started simultaneously from a point and traveled uniformly at their present speeds of motion. This time is the same for all galaxies, being the 1,800 million years just mentioned. Again the ratio of these two units is a very large number; this time it is 4.5×10^{39}, which is very near to the large numbers already mentioned. Again we must assume that the agreement is not a mere accident but must represent something in the order of nature.

We do not know what is the explanation of these apparent coincidences, but they seem to conceal something which has not yet been fully explained and which, when fully understood, may prove to be of outstanding importance. It is true that Eddington's researches provide an explanation but only in a rather special and very recondite form; it looks as though this explanation is only a special case of something simpler and far wider.

Some investigators have gone further than this and traverse, as it seems to me, very dangerous ground. The age of the universe, expressed in terms of the natural physical unit of time, proves once again to be of the order of 10^{39} and the suggestion is made that this also can be no mere accident, but it must express something in the fixed order of nature. The weakness in this argument is, as it seems to me, that the basic fact on which it rests can be put in the simpler form that the age of the universe is some one, two or three times the time in which space doubles its dimensions and that, when it is so expressed, it is difficult to find any "coincidence," either real or apparent. The supposed coincidence is seen to be merely a simple trans-

formation of one which has already been dealt with and we must not, so to speak, try to cash in on the same coincidence twice over.

Let us, however, waive the objection and accept the suggestion made. We have then to suppose that all the numbers of the order of 10^{39}, including the age of the universe, owe their approximate equality to something in the fixed order of nature. When the universe attains to 10 times its present age, the 10^{39} which measures its age will have increased to 10^{40} and all the other big numbers will have done likewise. Thus while the ratio of electrical to gravitational attraction will be ten times what it now is and so on, the number of particles in the universe will have increased 100-fold, so that creation must still be in progress. In brief, some or all of the quantities that we used to regard as unalterable constants of nature lose their quality of constancy and must change continually with the time. Milne was led to the same conclusion by a very different road; he reached it from a study of his cosmological principle. By whatever road we arrive, we come into a fantastic new world.

We may avoid the need for a continual creation of matter by supposing that the natural physical unit of time changes *pari passu* with the age of the universe. Then the measure of the age of the universe stays always the same as does also the number of particles in the universe. But now we find that either the mass or the charge of an electron must continually change.

All these seem strange to old-fashioned physics, but it simplifies some things and removes some difficulties. When, for instance, we study the spectrum of a nebula at 250 million light-years distance, we are in effect watching the emission of light from atoms as they were 250 million years ago. And a simple interpretation of what we see is that the atoms of those days were not the same as the atoms of to-day. Hydrogen atoms seem to have given out radiation of longer wavelength than they do now, and so were apparently larger—or perhaps their electrons moved more slowly in their orbits and so took longer to complete their revolutions, possibly because the electric attraction on them was less intense. There are many possibilities, each with its merits but also with many demerits.

Whatever the final solution of this vast problem may prove to be, it is already clear that there is no solution on the lines of the kind of dynamics that we learned at school. The mechanical interpretation of the universe fails as completely in the large-scale world of astronomy as it has already failed in the small-scale world of atomic physics. The quantum-theory has replaced mechanics in the physical world; we still do not know what is destined to replace it in the world of astronomy.

SCIENCE IN CHINA

By CHUNG YU WANG

COUNSELLOR, ACADEMIA SINICA; TECHNICAL EXPERT, MINISTRY OF ECONOMIC AFFAIRS

CHINA is, paradoxical as it may seem, the youngest and the oldest in science among the family of nations. The remark of Gore about Western civilization, that "the origin of many important discoveries lies buried in the obscurity of past ages," is none the less true of Chinese inventions and discoveries. It may be recalled that compass, paper, printing, glass, porcelain, gun-powder, etc., were discovered in China long before the time of Galileo, Bacon and Newton. In the realm of physical and biological sciences, some fundamental conceptions may be found buried in some Chinese ancient classics.

In the twelfth and thirteenth centuries, as a reaction against the "Subjective Philosophy" of Zennism, the "Rational Philosophy" of the Neo-Confucian philosophers was heralded in with the slogan "go to the things and investigate their reasons," a phrase as if taken out of Bacon's "Novum Organum." The greatest leaders of this movement were Chang I (1022 to 1107 A.D.) and Chu Hsi (1129 to 1200 A.D.). Chu Hsi wrote: "In every human mind, there is the knowing faculty; and in everything there is its reason. The incompleteness of our knowledge is due to our insufficiency in investigating the reason of things. The student must go to all things under heaven, beginning with the known principles, and seeking to reach the utmost. After sufficient labour has been devoted to it, the day will come when all things will suddenly become clear and intelligible" (translation by Dr. Hu Shih). This statement sounds quite modern in the sense that it may be construed to indicate the problem and procedure of what is now called science. Unfortunately, in the ensuing centuries, this movement, due to the introverted mentality of its leaders, had degenerated into a mere study of the classics of the ancients, and through centuries of classical education, by which, as Carlyle pertinently remarks, "they do attempt to make their Men of Letters their governors," the study of science was muffled and stifled.

The real awakening of China to the spirit and character of science, due undoubtedly to the impact of the return of Chinese students, trained both in

pure and applied sciences in America and Europe, may be said to have begun only within the last twenty-five years, although desultory attempts to introduce western sciences into China had been made in times past. The interest and enthusiasm with which the Chinese are now leaning toward the pursuit of both pure and applied sciences may be gleaned from the fact that the percentage of students in higher institutions of learning in China, majoring in pure sciences, increased from 7.6 in 1928 to 13 in 1936, and that the percentage of students in both pure and applied sciences increased from 27 in 1928 to 43 in 1936; that is, within a period of about ten years the percentage of the number of students taking up either pure or applied sciences is about double.

The same trend of increase can be discerned in the number of Chinese students studying in the United States and Canada. The percentage of Chinese students studying both pure and applied sciences increased from 30 in 1934 to 50 in 1942, while that of Chinese students studying only pure sciences increased from 3 in 1934 to 10 in 1942.

More astonishing is the growth of learned societies and research institutes of both pure and applied sciences during recent years in China. Whereas before the establishment of the Chinese Republic in 1912, there were only a few insignificant so-called learned societies of sciences, in 1936 there were found fifty-three learned societies and research institutes for natural sciences and sixty-nine for applied sciences. Naturally, paralleling the growth of these societies and institutes, is the increase in the number of publications dealing with both pure and applied sciences. Thus there were published in 1936 forty-two different kinds of periodicals, bulletins or transactions, devoted exclusively to these sciences. However, it should be mentioned that not a few of these societies and publications, just mentioned, may seem mediocre in their activities and contents, if judged by the Western standard; yet, within only a span of about twenty-five years, they have fared pretty well as a whole in their contributions to science.

Science connotes research; and the research workers in science are mostly men trained in the higher institutions of learning. To borrow an apt analogy from Professor Pupin, it may be said "scientific and engineering research is the honey-gathering process; men trained and disciplined in this field of inquiry are the honey-gathering bees." Now it is gratifying to note that both the bee and the honey are in the process of becoming in Chinese higher institutions of learning. Before the present Sino-Japanese War, there were a hundred and eight institutions of higher learning, forty-two of which were universities, thirty-four independent colleges and thirty-two technological and professional schools. Since the war began in 1937, fifty-six Chinese universities and colleges have been moved into Free Chnia, seventeen have been suspended, while the remaining thirty-five institutions in occupied China have led a precarious existence and certainly not a few of them have been closed.

About less than fifty years ago there did not exist in China any institutions of learning worthy of the name of a university. In fact the first government university, wherein sciences were taught, of necessity, in a mediocre manner, was established in 1895. It is indeed remarkable that within this short span of years China has almost caught up with the other nations in the pursuit of sciences which has taken the United States about a century and the European countries about three centuries to reach the position in which they stand to-day. This urge on the part of the Chinese to take up science in such an accelerating rate has been in a large measure due to the catalytic action of both American and European scientific thoughts on the Chinese mind.

Foremost among the many scientific research institutions in China are the Research Institutes of the Academia Sinica and the Geological Survey of China.

The Academia Sinica was established as a government institution in 1927 and is constituted of eleven institutes; they are the Institute of Physics, the Institute of Chemistry, the Institute of Engineering, the Institute of Biology, the Institute of Astronomy, the Institute of Geology, the Institute of Meteorology, the Institute of Mathematics, the Institute of History and Philology, the Institute of Social Sciences and the Institute of Psychology. These various institutes have been removed to different parts of Free China since the commencement of the present Sino-Japanese War. Dr. Chiu Chia-hua is now acting president of the Academia Sinica.

The Institute of Physics, originally located in Shanghai, has been moved to Kweilin and Kunming. In addition to the manufacture of scientific instruments for educational institutions, construction of radio broadcasting equipment and the manufacture of vibrator rectifiers, it is now engaged in the design of super-hetero-dyne receivers with crystal filters, researches on terrestrial magnetism, and on the magnetic properties of ferro alloys and steels.

The Institute of Astronomy, now located at Kunming, is engaged in the following lines of research and activities: solar research, photographic studies of variables and comets, determination of latitudes and longitudes and the studies of star clusters in the galactic system, orbits and ephemerides of comets and planetoids.

The Institute of Meteorology in Chungking is now devoted to wartime military aeronautical needs. The

projected activities of the institute are the establishment of additional observation stations in the northwestern and southwestern provinces, the study of long-range weather forecasts and the use of wireless meteorological instruments.

The Institute of Engineering, whose past work in the research of iron and steel has been suspended for lack of proper equipment, is now carrying on in Kunming some research work along the following lines: tungsten metallurgy, manufacture of glass and survey of raw materials for glass manufacture.

The Institute of Geology, under the able direction of Professor J. S. Lee, has been doing excellent work in the field of Chinese geology. His contributions to Chinese geology are numerous, but his most outstanding works are his "Studies of Graptolites" and his treatise on the "Geology of China," which latter has become a classic for students of Chinese geology.

Of all the different branches of science now passionately pursued in China, the science of geology bears the most fruitful results. The story of the accomplishments of Chinese scientists in geology during the last twenty-five years is alone sufficient to demonstrate the innate quality of Chinese mentality for science. It is remarkable that as early as 1200 A.D., Chu-Hsi, the Neo-Confucianist, made the following observation: "In high mountains there are shells. They probably occur in the rocks, which are the soil of older days, and the shells once lived in the water. The low places became high, and the soft mud turned into hard rock."

It was an event of no small significance when the Chinese Geological Survey was inaugurated in 1916. This event was brought about by two brilliant Chinese scientists, Dr. V. K. Ting, now deceased, and Dr. Wong Wen-hao, now Minister of Economic Affairs and chairman of the National Resources Commission, who, of verity, may be regarded as fathers of geological science in China. Time does not permit me to enumerate here the contributions of the many Chinese geologists in the fields of paleontology and stratigraphy and other branches of geology. They can be found in the bulletins, memoirs and paleontological monographs, the latter grouped under the name of Palaeontologia Sinica, published by the National Geological Survey of China. However, it is appropriate for me to mention at this juncture the name of my old teacher, Dr. A. W. Grabau, who has had a great deal to do with the training of young Chinese geologists, inspiring and guiding them in their researches.

Due to the emergency of the war in China, it is but natural for Chinese scientists and technologists to turn their energy and efforts in winning the war. The seventeen laboratories of the National Resources Commission are doing researches in raw materials, in industrial techniques and in better production methods. Experiments are being carried on in finding the magnum bonum condition for the distillation of alcohol from fibrous plants; tung oil, once a valuable product for export, is being processed to yield synthetic gasoline and rubber; motors of different descriptions are manufactured in the electrical laboratory; the machine shop laboratory is turning out machines of every description for the various industries.

One outstanding achievement of geological sciences since the outbreak of hostilities in China is the discovery of an immense oil field, northwest of Lanchow, the capital city of Kansu Province. It is estimated that the reserves of this field contain fully 140,000,000 barrels of crude, equivalent to about 1/130 of the oil reserves in the United States. Efforts are under way to produce 10,000 barrels per day.

Japan's war of aggression has precipitated an unprecedented mass migration of Chinese students, both boys and girls, and their professors to the hinterland of China. The epic of the odyssey of these intellectuals treking thousands of miles with their books and laboratory equipments, through trials and tribulations, requires abler pen than mine to describe. From this you may readily imagine the difficulties under which science is now being pursued in Free China. In spite of such difficulties, in lack of materials and equipments, studies of sciences are being carried on. To show you how the Chinese people appreciate the value of science, I would like just to mention the fact that the People's Political Council, a war-time national parliament, recently convened in Chungking in October of last year, passed a resolution to increase the appropriation for scientific and academic researches.

In conclusion, allow me to voice one of the many hopes of Chinese scientists with respect to their future work after the termination of this global war. You have been helping China as a member of the family of the United Nations in many ways during the progress of this war. We thank you. We, as your colleagues, however, dare to bespeak your future help in the rebuilding of our bombed-out universities, laboratories and libraries, as soon as the pseudo-divine barbaric mission of the Japanese is crushed. We hope we are not unworthy of your help. The Chinese scientists in the future will, with renewed energy and zeal, do their share, by laying a brick here and there, in the building up of the Temple of Science.

OBITUARY

DEATHS AND MEMORIALS

DR. DAVID H. NEWLAND, state geologist of New York, who retired three years ago, died on October 18 at the age of seventy-one years.

DR. THEODORE DILLER, psychiatrist for the Altoona, Pa., Army Induction Center, died on October 6 at the age of eighty years.

A CORRESPONDENT writes: "Lieutenant Rolland F. Lang, of the civil engineering staff of the Michigan College of Mining and Technology, Houghton, was killed in action somewhere in the Southwest Pacific on October 7, a few days after his twenty-ninth birthday and fourteen months after he had been called to active duty as a reserve officer. Lieutenant Lang joined the faculty of the Michigan college three years ago. A graduate of South Dakota State College, he had taught at his alma mater for two years. He was a member of the American Society of Civil Engineers, the American Road Builders' Association, Scabbard and Blade, Blue Key, Delta Pi Chi Engineering Society and Kappa Delta Psi social fraternity. Both as a teacher and as a practising engineer, he was a young man of great promise; as an officer in the Army of the United States he had proved himself able and courageous."

THE Alumnae Association of the Woman's Medical College of Pennsylvania announces the publication of a series of addresses delivered at a service in memory of the late Dr. Martha Tracy, dean of the college from 1918 to 1940. Copies of the booklet may be obtained from the Alumnae Office at the Woman's Medical College. Proceeds of the sale will be placed in the Tracy Memorial Fund.

SCIENTIFIC EVENTS

THE POINT SYSTEM OF RATIONING[1]

WITH the inauguration of a point system of rationing on March 1, 1943, the Office of Price Administration became the administrative agency; and the public's traditional peacetime latitude of dietary choice, limited only by ability to pay, was abruptly curtailed. As point rationing was extended to include a broad range of meats, fats and processed foods, it became evident that certain institutions and certain groups of the population would, because of special dietary needs, require special consideration. Prominent among these were hospitals and those sick individuals whose illness demands rationed foods in amounts greater than that provided by their "points." On the Food Distribution Administration of the Department of Agriculture developed responsibility for the equitable distribution of food and therefore responsibility for assuring the needs of the sick and of institutions caring for the sick.

Furthermore, it was recognized that in recent years great advances have been made in the understanding of the vital role that dietary components play in the body economy under conditions of health, stress, disease and convalescence. The role of these components can be evaluated with increasing precision in the light of modern nutritional research. Therefore in April, 1943, at the request of Roy Hendrickson, director of the War Food Administration, Dr. Ross G. Harrison, chairman of the National Research Council, appointed a group of nationally known physicians to advise the War Food Administration concerning the extent of these special needs and the best method of meeting them.

Within the Division of Medical Sciences of the council this group was organized as the Subcommittee on Medical Food Requirements under the general jurisdiction of the Committee on Drugs and Medical Supplies, of which Dr. Walter W. Palmer, of Columbia University, is chairman. The subcommittee was composed of physicians representing various fields of medicine and consisted of Dr. William Stroud, Philadelphia, *chairman;* Dr. Cecil Striker, Cincinnati; Dr. Alton Ochsner, New Orleans; Dr. C. W. Munger, New York; Dr. Clark Finnerud, Chicago; Dr. Gilbert Levy, Memphis, and Dr. Walter W. Palmer (*ex officio*), New York. A first meeting was held in Washington on April 30 and May 1 at which the broad outlines of the problems involved were reviewed and discussed. At this and at subsequent meetings, representatives of the Civilian Food Requirements Branch, War Food Administration, and of the Food Rationing Division, Office of Price Administration, were present to acquaint the subcommittee with administrative aspects of the rationing program. Other committees of the National Research Council were called in consultation, notably the Committee on Surgery and the Subcommittee on Tuberculosis. The opinions of individual specialists in certain fields of medicine were solicited. Finally all recommendations of the subcommittee were reviewed and approved by the parent Committee on Drugs and Medical Supplies before transmission to the War Food Administration.

[1] The *Journal* of the American Medical Association.

RARE CHEMICALS

THE following chemicals are wanted by the National Registry of Rare Chemicals, Armour Research Foundation, 33rd, Dearborn and Federal Streets, Chicago, Ill.:

p-Aminophenylarsenoxide
Arsenophenylglycineamide
Halarsol
Halarsol thioglycollate
Arsacetin, reduced
Atoxylthioglycollate, reduced
Stovarsolthioglycollate, reduced
1,3,5-Triaminobenzene trihydrochloride
Diphenyl selenium difluoride $(C_6H_5)_2SeF_2$
Di-p-tolyl selenium difluoride $(CH_3C_6H_4)_2SeF_2$
Dodecyl amine hydrochloride
Dodecyl amine acetate
Adenosinetriphosphate
Adenosinediphosphate
Adenylic acid (muscle) up to 25 grams
Inosine
Spermine (2 grams)
Spermidine (2 grams)
Trypansamidethioglycollate, reduced

THE FINNEY-HOWELL RESEARCH FOUNDATION

ANNOUNCEMENT has been made by the Finney-Howell Research Foundation, Inc., that all applications for fellowships for next year must be filed in the office of the foundation, 1211 Cathedral Street, Baltimore, Md., by January 1, 1944. Applications received after that date can not be considered for 1944 awards, which will be made March 1, 1944.

This foundation was provided for in the will of the late Dr. George Walker, of Baltimore, for the support of "research work into the cause or causes and the treatment of cancer." The will directed that the surplus income from the assets of the foundation together with the principal sum should be expended within a period of ten years to support a number of fellowships in cancer research, each with an annual stipend of two thousand dollars, "in such universities, laboratories and other institutions, wherever situated, as may be approved by the Board of Directors."

Fellowships carrying an annual stipend of $2,000 are awarded for the period of one year, with the possibility of renewal up to three years; when deemed wise by the board of directors, special grants of limited sums may be made to support the work carried on under a fellowship.

Applications must be made on the blank form which will be furnished by the secretary or any member of the board of directors.

THE BORDEN AWARD IN NUTRITION

THIS award is given in recognition of distinctive research by investigators in the United States and Canada which has emphasized the nutritive significance of the components of milk or of dairy products. The award will be made primarily for the publication of specific papers, but the judges may recommend that it be given for important contributions over an extended period of time. The award may be divided between two or more investigators. Employees of the Borden Company are not eligible for this honor.

To be considered for the award, nominations must be in the hands of the chairman of the nominating committee by February 1, 1944. The nominations should be accompanied by such data relative to the nominee and his research as will facilitate consideration for the award.

HENRY A. MATTILL,
Chairman of the Nominating Committee
THE STATE UNIVERSITY OF IOWA,
IOWA CITY, IOWA

JOINT ANNUAL MEETING OF SCIENTIFIC SOCIETIES IN CHINA

A JOINT annual meeting of the Science Society, the Zoological Society, the Botanical Society, the Meteorological Society, the Mathematical Society and the Geographical Society of China was held at Pehpei, Chungking, on July 18, 19 and 20. Despite the hot weather prevailing then, 240 members attended the meeting, which was presided over by Dr. Wong Wen-hao. In his opening address Dr. Wong said that a joint meeting like this was especially desirable in wartime, in that it is economical in time, labor and expenditure and enhanced cooperation between societies of a related nature. In view of the present tendency to overlook the study of pure science, Dr. Wong remarked that truth is what the scientist values most, regardless of whether or not practical use can be derived from it; and he urged the pure scientists to be firm in their stand. As a geologist and Minister of Economic Affairs, he illustrated with first-hand examples to show how what appeared to be purely a geological study at first, turned out later to be of much practical value in the detection of China's natural resources. The address of the Generalissimo was then read, in which he declared: "Pure science is the foundation of all applied sciences. If we wish to stand up among the modern great nations there must not be the slightest tardiness in the prosecution of pure science." While most of the official emphasis has been laid on the practical side in the recent tide of national industrialization, it will do the nation good to remind people of the significance of pure science.

In the business meeting, held on the first afternoon, Dr. J. Needham, F.R.S., was elected honorary member of the Science Society of China, in appreciation of his distinguished academic work and his service in Sino-Western Science Cooperation which has been so effectively carried on during the past six months.

The six societies spent two forenoons in communicating original papers of their respective sciences. More than three hundred papers were read. Brief abstracts of these papers will be published before long in Chinese with additional English titles.

One of the two remaining afternoons was devoted to discussing the topic, "Science and National Reconstruction," with special reference to the problem of how science is to be promoted in China. Opinions were formulated on the following four points, which were presented to the Chinese government for their immediate adoption.

(1) The government is requested to provide a large fund in the forthcoming national budget for, and only for, the furtherance of scientific research and of the scientific education of the masses.

(2) The personnel and equipment of the leading science institutes, such as those of Academia Sinica, must be materially augmented.

(3) Efforts must be made on the part of the Government to establish cooperation between the scientists on the one hand, and the officials in charge of the planning of national reconstruction on the other, so as to render the resulting plans all the more practical and fruitful.

(4) While the Government is considering sending a large number of young scientists abroad, it is deemed appropriate that such opportunities should be extended to mature scholars also. Here again, the Government is requested not to neglect pure science in favor of applied sciences and technology.

The last afternoon of the meeting was reserved for a discussion on "International Science Cooperation." To familiarize the audience with the subject under discussion, four specialists were asked to talk about the cooperative measures hitherto undertaken, along with the sound results accomplished therefrom, with respect to agriculture, industry, meteorology, medicine and public health. Dr. Needham's address, entitled "International Science Cooperation in War and Peace," was read next by Dr. H. C. Zen, president of the Science Society of China, in which the present position of Sino-Western Science Cooperation of the United Nations in the Asiatic theater was reviewed. He urged, above all, that Science Cooperation Service should be made a regular part of the forthcoming United Nations Relief and Reconstruction Board. The members were unanimous in the opinion that international science cooperation, founded on international understanding and good-will, is worth striving for. Indeed, the Chinese scientists seek cooperation with no less enthusiasm than their friends of the West.

The meeting was concluded at nightfall on July 20. A scientific exhibition intended for the public was arranged by the societies during the session.

THE SOCIETY OF CHEMICAL INDUSTRY

WALLACE PATTEN COHOE, of New York, was inducted as president of the Society of Chemical Industry, the international organization with headquarters in London, at a dinner meeting held on October 22 at the Waldorf-Astoria. About eight hundred chemists and industrialists, including heads of America's leading chemical industries, attended. The meeting was under the patronage of King George VI. The British Government was represented by Sir Gerald Campbell, K.C.M.G., British Minister at Washington, who presented the chains of office to Mr. Cohoe and delivered an address.

The event was a continuation of the proceedings of the annual meeting of the society held in London on July 9, at which Mr. Cohoe was elected president to succeed Dr. William Cullen, of London, and which was adjourned to reconvene in New York City. A cable message of felicitation from the council of the society assembled in London and signed by Dr. Cullen was read at the dinner, at which Mr. Cohoe delivered the inaugural address. Dr. Foster D. Snell, head of Foster D. Snell, Inc., of Brooklyn, and chairman of the American section of the society, presided.

Honorary membership in the society, by order of the council in London, was bestowed on Academician Alexei Bach, Soviet biochemist, and Dr. Te-Pang Hou, Chinese industrial chemist. These were conferred by Mr. Cohoe. The citations were as follows:

ACADEMICIAN ALEXEI BACH: In commemoration of his lifelong activities as a research worker in the realm of biochemistry, which branch of chemical science he has enriched by his pioneering work.

Born in 1857, he is a member of the Academy of Sciences, which controls the researches of many thousands of workers who are engaged mainly on fundamental problems. Together with Professor Zbarsky he established the Chemical Institute, named after L. Karpov, and is now its director. In 1920 he established the Biochemical Institute under the People's Commissariat for Health, and both prior to this and since he has been responsible for many original scientific papers which have won for him and his coworkers international renown.

The council, in deciding to bestow this honor, selected with great care one whom they considered worthy, for in addition to his manifold contributions to our knowledge, he has through his long life shown unselfish devotion to science. Moreover, his career illustrates to a remarkable degree the beneficial influence which a man of high scientific attainments can have on the general life of a community.

DR. TE-PANG HOU: In recognition of his distinguished pioneer services in establishing in China those chemical industries essential to the industrial life of a modern nation.

Born in Foochow, China, in 1890, he is a life member of the Chinese Institute of Engineers and medalist thereof

"for the greatest contribution to the Chinese Chemical Industry"; life member of the Science Society of China; bachelor of science, master of arts and doctor of philosophy; and author. Respected in China for his chemical ability and successful achievements, he has by his personality, energy and distinguished position been able to inspire and lead his fellow countrymen to greater technological accomplishment.

The council, in deciding to bestow this honor, is conscious that Occidental Nations are indebted to the ancient Chinese civilization for their first knowledge of silk, paper, printing, porcelain, gunpowder and the magnetic compass, and has selected with great care this distinguished son of China who has carried Western chemical science to his own country, thus enabling the West to repay, in part, a debt, centuries old, to the Chinese nation.

SCIENTIFIC NOTES AND NEWS

AT the Chicago meeting of the American Institute of Mining and Metallurgical Engineers the William Lawrence Saunders Gold Medal was presented to George B. Harrington, president of the Chicago, Wilmington and Franklin Coal Company, for "distinguished achievement in mining." The Anthony F. Lucas Medal was presented to Charles V. Millikan, chief petroleum engineer of Amerada Petroleum Corporation, in recognition of "his contributions to engineering in the development and production of petroleum."

DR. GILBERT E. DOAN, head of the department of metallurgical engineering of Lehigh University, and his two associates, Dr. John Frye and Robert Stout, have received the Lincoln Award of the American Welding Society in recognition of research "representing the greatest contribution to the advancement and use of welding for the year 1943."

DR. FRED C. KOCH, Frank P. Hixon distinguished service professor of biochemistry, emeritus, of the University of Chicago, was the guest of honor at a dinner on October 1, given by the Chicago Section of the American Institute of Chemists. He was presented with a scroll enumerating his many contributions to science.

The Psychological Bulletin reports that the establishment of a new loan fund at Ohio University, to be known as the "James P. Porter Loan Fund in Psychology," was announced recently by Dr. A. C. Anderson, professor of psychology, who headed a committee to formulate plans to honor Dr. Porter on his recent retirement from the teaching faculty. The money for the loan fund was contributed by former students and by members of the staff of the department. At a dinner, Dr. Porter, who joined the faculty of Ohio University as professor of psychology in 1922, was presented with a book of letters from former students. For many years he was editor of *The Journal of Applied Psychology*.

A SKETCH of the career of Dean Emeritus Mortimer Elwyn Cooley, of the College of Engineering of the University of Michigan, is given in the July number of the *National Engineer*. It includes an article by Dean Cooley, entitled "Reminiscences of a Pioneer Engineer and Educator." The Mortimer E. Cooley Bridge, between Cadillac and Manistee, Michigan, and the Mortimer E. Cooley Foundation of Engineering were named for Professor Cooley.

THE Grocery Manufacturers of America have chosen Sir John Boyd Orr, who was largely responsible for improving the nutritive quality of the English diet in the face of wartime food shortages, as the 1943 recipient of its annual award. The presentation ceremony will be broadcast on November 4 over a two-way, transatlantic hookup by the Blue Network at the war conference of the manufacturers in New York City. Surgeon General Thomas Parran, of the U. S. Public Health Service, has been invited to present the award in an address at the conference. Sir John will accept it over the air from England.

OFFICERS of the American Society for Metals have been elected as follows: M. A. Grossmann, director of research of the Carnegie-Illinois Steel Corporation, *President;* Dr. Kent R. Van Horn, research metallurgist of the Aluminum Company of America, Cleveland, *Vice-president,* and Harry D. McKinney, vice-president and works manager of the Driver-Harris Company, Harrison, N. J., *Treasurer.* William H. Eisenman will continue as national secretary of the society.

DR. HAROLD C. WIGGERS has resigned as assistant professor of physiology at the Medical School of Western Reserve University to become associate professor of physiology in the College of Medicine of the University of Illinois in Chicago.

DR. MAX MYER WINTROBE, formerly associate professor in the department of medicine at the Johns Hopkins University, has become professor of internal medicine and head of the department of the School of Medicine of the University of Utah.

DR. WILLIAM I. MYERS, head of the department of agricultural economics and farm management and acting dean since the death of Carl E. Ladd on July 23, has been appointed dean of the New York State College of Agriculture, Ithaca, N. Y.

DR. JOHN LAURENCE KASK, formerly assistant director of the International Pacific Salmon Fisheries Commission, has been appointed associate curator of fishes of the California Academy of Sciences.

THE Desert Museum at Palm Springs, Calif., which was closed for the summer on May 15, was opened on October 16. The curator, Sam Hinton, having been appointed head of the department of hematology in the Medical Hospital (Torney Hospital) at Palm Springs, Professor and Mrs. T. D. A. Cockerell have taken charge of the museum.

VERNON E. BROCK, biologist with the Department of Research of the Fish Commission of Oregon, has been given leave for the duration of the war to become assistant to the administrator of fishery production and fishery analyst in the Office of the Coordinator of Fisheries. His headquarters are in San Francisco, where he is engaged in the administration of the California sardine fishery.

C. MAX HULL, for the past eight years a research chemist with the Standard Oil Company of Indiana, has been appointed research associate in the Research Foundation, Ohio State University.

DR. CHARLES F. MCKHANN has resigned as professor of pediatrics and communicable diseases at the Medical School of the University of Michigan and as professor of maternal and child health in the School of Public Health, to become assistant to the president of Parke, Davis and Company. He will devote his time entirely to the scientific activities of the company.

WILLIAM S. RICHARDSON has been named head of the newly established chemicals division of the B. F. Goodrich Company at Akron, Ohio.

THE American Philosophical Society has made a research grant of $1,000 to Dr. Herbert C. Brown to further his studies of steric strains as a factor in the stability of addition compounds. Dr. Brown recently joined the faculty of the College of Liberal Arts at Wayne University as assistant professor of chemistry. He is now coordinator and consultant for an Army research project being carried out by the University of Chicago and the Ethyl Corporation.

DR. HOWARD C. NAFFZIGER, professor of surgery in the Medical School of the University of California, has returned to San Francisco after making a survey of military medicine in England, Scotland, Sicily, North Africa and the Near East.

CAPTAIN WINCHELL M. CRAIG, U. S. Naval Reserve, chief surgeon at the Naval Hospital, Bethesda, Md., will deliver the W. J. and C. H. Mayo Memorial Lecture at the Medical School of Dartmouth College on November 5. The title of his address will be "Warriors against Disease."

DR. C. H. MATHEWSON, chairman of the department of metallurgy of Yale University, gave the Campbell Memorial Lecture of the American Society for Metals, following the annual meeting.

THE Thomas William Salmon Lectures will be given on November 5, 12 and 19 at the New York Academy of Medicine by Dr. Abraham Arden Brill, lecturer on psychoanalysis at Columbia University. His subject will be "The Psychotherapeutic Contribution to Psychiatry."

THE American Association of Physics Teachers will hold its thirteenth annual meeting jointly with the American Physical Society at Columbia University from January 13 to 15, 1944. Headquarters will be at the Hotel Pennsylvania. The third Richtmyer Memorial Lecture will be delivered at this meeting and the presentation of the Oersted Medal will be made. There will be joint sessions with the American Physical Society, invited and contributed papers, exhibits of newly developed instructional equipment and the annual business meeting. Professor R. C. Gibbs, of Cornell University, is chairman of the program committee. Members who desire to contribute papers (10 minutes) or exhibits to the program are asked to send titles and abstracts not later than November 20.

AUTHORITIES on public health from six Latin American universities are visiting the United States under the auspices of the Office of the Coordinator of Inter-American Affairs and the Pan-American Sanitary Bureau in Washington, D. C. After a tour of schools of public health, members of the deputation will conclude their visit to the United States with presentation of a report on South American public health schools at the annual meeting of the Association of Schools of Public Health to be held at the University of Michigan on November 7. At the same time a plan for the interchange of students, offering the facilities of their universities for the study of tropical diseases, will be presented. Dr. Oscar Vargas, San Jose, Costa Rica, representing the Pan-American Sanitary Bureau, is acting as leader of the group. The other members include: Alberto Zwanck, professor of hygiene at the University of Buenos Aires; A. H. dePaulo-Souza, professor of public health at the University of São Paulo, Brazil; Carlos Enrique Paz-Soldan, professor of hygiene at the University of San Marcos, Lima, Peru; Federico J. Salveraglio, professor of hygiene at the Medical School, Montevideo, Uruguay; Mario Prado, vice-director of the Institute of Bacteriology, Santiago, Chile; and Hernan Romero, professor of preventive medicine and public health at the University of Chile, Santiago.

A CONFERENCE on geodesy, aeronautical charts and topographic maps in which twenty-five distinguished visitors from Latin America and Canada took part, was held recently in Washington. The conference was sponsored by the American Geographical Society at the suggestion of the Committee on Cartography of the Pan-American Institute of Geography and History, of which Pedro C. Sanchez is director. Dr. Andre C. Simonpietri is the secretary of the Commission on Cartography. Headquarters are in Mexico City. The purpose of the committee is to promulgate uniform standards and technical methods which can be adopted by all the countries involved; to improve education and training in the science of map making through the exchange of professors and technical personnel. Reports are being compiled in each country to indicate the status of mapping, complete with index charts showing geodetic control, completed and under way. Biographical data are being assembled on those engaged in cartographic work in each country and a glossary of scientific terms used in mapping is being prepared in English, Spanish and Portuguese. Following the conference in Washington the delegates inspected the production of aerial mapping equipment by the Bausch and Lomb Optical Company.

As reported by Science Service, cultural leaders in the Western Hemisphere recently met in Washington in wartime session to consider how best to promote scientific and scholarly cooperation. The Inter-American Committee on Intellectual Cooperation, under the chairmanship of Dr. Miguel Azorio de Almeida, Brazilian physiologist, is a Western Hemisphere regrouping of the national committees on intellectual cooperation that were organized under the League of Nations a decade ago. Conferences were held in the buildings of the Pan American Union and the Carnegie Endowment for International Peace, with those organizations and the Division of Cultural Relations of the State Department cooperating in the program. Dr. Waldo G. Leland, director of the American Council of Learned Societies, recently named chairman of the American Committee on Intellectual Cooperation, has been instrumental in arranging the conference. The American delegate to the meeting is Dr. James T. Shotwell, of Columbia University, now honorary chairman of the American committee. Other delegates are Dr. Victor Lascano, of Argentina, Dr. Julian Nogueira, of Uruguay, Dr. Alfonso Reyes, of Mexico, Dr. Cosme de la Torriente y Peraza, of Cuba, and Dr. Oscar Vera, of Chile. Dr. Herminio Rodriguez is secretary of the committee. Technical experts present included Dr. Robert Valeur, of New York, Dr. Mariano Brull, of Cuba, and Dr. Antonio Castro Leal, of Mexico.

THE Earl E. May Seed Company has made a gift of $75,000 to Iowa State College, to be spent over a period of five years, for a study of the basic problems relating to the growth and development of the corn of Mexico and Central and South America, and the contribution the corn of those areas may be able to make to the United States.

IT is reported in *Chemical and Engineering News* that a National Security Award has been established by the Office of Civilian Defense to give recognition to outstanding achievements of certain essential facilities in protecting the safety of employees, plants and production schedules from air raids, fire, sabotage and accident. A Board of Review has been formed to pass final judgment on records of plants nominated for the award.

A UNITED PRESS dispatch reports that the Swedish Government has decided against the awarding of Nobel prizes for peace, literature, physics, chemistry or medicine in 1943.

DISCUSSION

SYNAPSIS AND SYNGAMY AS STIMULATING PROCESSES OF PLANT DEVELOPMENT[1]

THE structural features of sexual reproduction in higher plants have been worked out and described with great precision, yet very little is known of the physiological aspects of this very important phase of their life. This despite the fact that most of the economic plants are grown for their seeds and fruit—organs and tissues associated directly or indirectly with reproduction. Even a cursory observation of many species, especially the annuals, should convince one that sexual reproduction has a very marked effect on growth and development, certain important aspects of which are now being recognized and studied.

In a series of experiments, chiefly with horticultural plants, the effects of developing flowers and fruit on vegetative growth have been amply demonstrated by the senior author,[2] which leaves little doubt about the conspicuous physiological control that these organs exert on metabolism. The influence, characterized by

[1] Contribution from the Department of Horticulture, Missouri Agricultural Experiment Station Journal Series No. 909.

[2] A. E. Murneek, *Plant Physiol.*, 1: 3–56, 1926; 7: 79–90, 1932. *Mo. Agr. Exp. Sta. Res. Bul.*, 106, 1927. *Proc. Am. Soc. Hort. Sci.*, 21: 274–276, 1924; 40: 201–204, 1942. *Growth*, 3: 295–315, 1939.

various degrees of inhibition in the subsequent development and function of flowers, leaves, shoots and roots, is shown most markedly after reproduction has progressed towards completion, *viz.*, fruit and seed formation.

An examination in detail of some of the earlier, very significant though less evident, stages of reproduction has disclosed, that, in addition to an inhibitory or retarding influence, as is exhibited during fruit and seed development, a more or less specific stimulation also occurs with initiation of fruit development and the early stages of fruit setting.[3] Hence coincident with sexual reproduction, vegetative growth is first stimulated and later retarded, in tandem order as it were.

The concept that, as a result of gametic union, growth is stimulated was introduced and demonstrated some time ago (Murneek, 1926),[3] while later observations suggested a similar stimulation during synapsis (Murneek, 1937).[3] As a result of further study of the problem we have now on record considerable proof, details of which will be presented in a forthcoming publication, that during the process of sexual reproduction metabolism is indeed accelerated, specifically at the approximate time of union of the chromosomes at meiosis (synapsis) and during union of nuclei at fertilization (syngamy). The two periodic stimulations in growth, therefore, have their origins in the process of fertilization with its two cytogenetically important phases, chromosome conjugation and gametic union, accepting the view long current that synapsis is the final or culminating phase of the sexual process, and disconsidering for the present exceptional cases or alternating mechanisms, as in certain polyploids or parthenogenetic organisms (Sharp, 1937).

It has been possible for us to demonstrate repeatedly by means of removal of reproductive organs at different stages of their development from a variety of plants (spinach, cucumber, strawberry and sour cherry) that a period of renewed growth, presumably arising from increased metabolic efficiency of the roots and leaves, follows each of the above two crucial phases of reproduction. These intervals of accelerated activity in the plant manifest themselves by increases in vegetative extension, the production of fresh and dry matter, the absorption of soil nutrients, and the accumulation of products of photosynthesis. In inflorescences of many plants the post-synaptic and post-syngamic periods are characterized by an augmented elongation and changes in movement of the pedicels. Two spurts in growth and alterations in movement usually occur, one during bud development, the other following fertilization of the egg.

[3] A. E. Murneek, *Mo. Agr. Exp. Sta. Res. Bul.*, 90, 1926. SCIENCE, 86: 43–47, 1937. S. H. Wittwer and A. E. Murneek, *Proc. Am. Soc. Hort. Sci.*, 40: 205–208, 1942.

Determinations of catalase activity in developing flowers and accessory tissues of the pear tree and corn plant showed two prominent peaks. The first increase followed synapsis in the microspore mother cells, the second occurred after nuclear fusion in the majority of the embryo sacs.

Following the initiation of chromosome conjugation in the staminate and fertilization in the pistillate flowers of corn, substances possessing marked growth stimulating properties (growth hormones) were produced, the greatest concentration being attained within the tassels 10 to 14 days after beginning of synapses, and in immature kernels an equal period subsequent to syngamy. The pre-synaptic stage in the male and the pre-syngamic period in the female inflorescences were distinguished by an absence of growth substances in the respective reproductive organs. The two maxima representing hormone concentration correspond quite precisely with (a) the peaks in catalase activity, and (b) the spurts in growth following gametophyte and embryo inception.

Extracts of the immature corn kernels, applied in lanolin paste, were active in fruit setting and parthenocarpic fruit induction in the tomato. The set, yield and size of the fruit were superior to that obtained by means of artificial pollination and by the use of synthetic growth substances.

These results have an unexpected confirmation and permit the interpretation of certain heretofore unintelligible results secured by Kreusler and his coworkers on the growth of the corn plant and published some 60 years ago.[4] A critical reexamination of their data and consideration of the time factor in morphogenesis of the corn plant reveal a striking correlation between (a) periods of greatest vegetative extension, accumulation of dry matter, absorption of soil nutrients and accumulation of photosynthetic products (Kreusler's data) and (b) peaks in production of growth hormones in the reproductive organs, as disclosed by our studies. The intervals of maximal increase in stimulating substances followed closely in all cases the beginning of synapses in the flower buds and embryo initiation in the young fruit.

A. E. MURNEEK
S. H. WITTWER

UNIVERSITY OF MISSOURI

NAME AND CLASSIFICATION OF THE CURLY-TOP VIRUS

SYMPTOMS induced in affected plants are the best characteristics now known for the classification of phytopathogenic viruses. The symptoms induced in beets as well as in other hosts by the curly-top virus complex would lead to the placing of this virus in the

[4] U. Kreusler, *et al.*, *Landw. Jahrb.* 6: 759–786, 787–800, 1877; 7: 536–564, 1878 and 8: 617–622, 1879.

leaf-curl group described by Holmes[1] as the family *Rugaceae* with the one genus, *Ruga*. Holmes has placed the curly-top virus in the yellows group, the family *Chlorogenaceae,* and in the single genus, *Chlorogenus,* but the symptoms induced by the curly-top virus have little in common with those used to describe the family *Chlorogenaceae*.

The specific epithet, *eutetticola,* is in error from an orthographic viewpoint because the proper root for the first member should have been *eutettig-*. The specific epithet should, therefore, be changed. Changing the specific epithet affords the opportunity to choose a term that characterizes the curly-top virus and is not out of accord with present knowledge. The specific epithet, *eutetticola,* was assigned by Holmes to the curly-top virus when no other vector was known except the beet leafhopper, *Eutettix tenellus* (Baker). It is now known that this leafhopper failed to transmit the variety of the curly-top virus that occurs in Argentina. Another vector, *Agalliana ensigera* Oman, serves as vector there.

Because the curly-top virus causes in sugar beet and other host plants arrested development of invaded tissues, leaf curl, enations and other deformities rather than the symptoms used to describe the genus *Chlorogenus,* we propose that the curly-top virus be shifted to the genus *Ruga*. And, in view of the fact that the virus causes rough, pointed enations on the veins and rough distortion of the leaves and also in view of its vector relationships, we propose that its specific epithet be changed to *verrucosans,* to mean causing rough swellings. The name of the curly-top virus then will be *Ruga verrucosans*.

Detailed studies on the Argentine curly top will be published later in a more extensive paper.

EUBANKS CARSNER
C. W. BENNETT

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RIVERSIDE, CALIF.

THE PREPARATION OF SODIUM IODOACETATE

IN a recent issue of SCIENCE[1] there appeared a request for sodium iodoacetate in the section devoted to "Rare Chemicals." It is difficult to obtain this reagent in pure form by the procedure customarily employed.[2] The present note describes a simple method for preparing pure sodium iodoacetate in good yield from monochloroacetic acid.

Monochloroacetic acid (10 gm) is dissolved in pure dry acetone (150 ml) containing sodium iodide (24 gm). The solution turns brown and separation of sodium chloride begins almost immediately. The reaction is complete in 6 to 8 hours at room temperature. The sodium chloride is removed by filtration through sintered glass and washed with a little acetone. The combined filtrates are adjusted to pH 6.8, using 40 per cent. sodium hydroxide. The precipitate which separates is filtered and washed with acetone, with chilled absolute alcohol and finally with dry ether. The product is powdered and dried *in vacuo*. It is quite colorless and free from halide ion. Yield: 20 gm (91 per cent.).

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ISOTEL, ISOTELIC

IT is surprising that no one has previously suggested (so far as the writer is aware) the use of the term *isotelic* (Gr. isos = same; telos = purpose) to designate the relationship between entities which have the same purpose.

The familiar term *isomer* (pl. isomers) is used in chemistry to designate compounds made up of the same parts (Gr. isos = same; meros = part). In an exactly analogous way it seems logical and convenient to designate compounds which perform the same function as *isotels* (Gr. isos = same; telos = purpose).

In biochemistry the need for such terms appears real in view of the fact that numerous cases can be cited of distinct chemical compounds which can replace one another, for example, in the diet. Thus there are numerous *isotelic* forms (*isotels*) of vitamin D as well as other vitamin *isotels* (including biotin *isotels*).[1] In animal nutrition methionine and choline may be said to be partially *isotelic*. In yeast nutrition β-alanine and pantothenic acid may be said to be *isotelic,* since one may replace the other in nutrient media.

The term *vitamer* has been suggested[1] to designate vitamin forms which can replace one another. This term was obviously suggested also by the word isomer. Unfortunately, however, the wrong portion of the word isomer was used and as a result *vitamer,* aside from having a mixed Latin and Greek origin, has a definite but false etymology, meaning, life-part. This is meaningless so far as the proposed use of the term is concerned.

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[1] F. O. Holmes, "Handbook of Phytopathogenic Viruses." Burgess Publishing Company, Minneapolis, 1939.
[1] SCIENCE, 97: 304, 1943.
[2] W. A. Drushel and G. S. Simpson, *Jour. Am. Chem. Soc.*, 39: 2453, 1917.

[1] D. Burk and R. J. Winzler, SCIENCE, 97: 2507, 57-60, January 15, 1943.

SCIENTIFIC BOOKS

SOIL SCIENCE

Fundamentals of Soil Science. By C. E. MILLAR and L. M. TURK. Pp. xi + 462. 56 tables and charts, 78 figures and a glossary of terms. New York: John Wiley and Sons. 1943. $3.75.

THE authors, professor and head of the department of soils and associate professor of soils, respectively, at Michigan State College of Agriculture, East Lansing, Michigan, announce in the preface that the book was prepared for use as "a college textbook, a reference book for farmers and owners of farm lands, and as an aid to any one desiring information on soils and their culture."

Those who have made any attempt to teach soil science well realize the particular difficulties of subject-matter organization which the field of study represents. The task is not simplified by the need, in most university departments of agriculture, for serving not only students who are later to become specialists in soils but also those who are not soils majors but who should, nevertheless, have a fair general knowledge of soil science. When to the needs of these groups are added the demands of farmers and landowners, the preparation of a single, readable and satisfying book for all is a complicated undertaking.

The authors have dealt with the subject-matter in nineteen chapters throughout which photographs, figures and tables are fairly uniformly distributed. Many of the figures are new to text-books on soils and are valuable additions. Each chapter of the book contains lists of "Objectives" and "Questions" which are subject-matter headings, and should be of use to the beginning student. Chapters I to IX inclusive, and XV, which deal mainly with development, classification, physical and chemical properties, moisture, organisms, organic matter, soils and agriculture of arid regions, contain material which may properly be regarded as contributing primarily to knowledge of the fundamental properties of soils. These chapters cover about two thirds of the text. The remaining nine chapters are concerned with plant nutrition, fertilizers and fertility maintenance in soils, irrigation, soil in relation to fruit and lawn production and soil in relation to economics (productivity ratings of soils and soil resources): all subjects which, however valuable, are more closely connected with soil manangement, crop production and land evaluation than with fundamental soil science. In the earlier chapters there is also incorporated a considerable amount of material of an applied nature, *e.g.*, several sections on kinds of tillage implements, time and depth of tillage are included in the chapter on the physical and chemical properties of soils; a chapter on lime, with sections on the agricultural sources of lime, chemical guarantees and fineness, follows the chapters on chemical properties and soil reaction; the chapter on soil moisture includes sections on tile drainage, size of tile and so forth. This method of presentation undoubtedly adds to the interest of the subject, especially to the student with farm experience. The question nevertheless persists as to whether the method allows sufficient time at this stage in his training for the fullest development of the less easily acquired background necessary to the student majoring in soils, whose great opportunity is at hand to acquire the more difficult fundamentals.

The book is directly written, although at the cost of some oversimplification, for example, in parts of the chapter on soil moisture and elsewhere, and much has been accomplished in integrating the various subject-matter divisions and making the entire book interesting and readable. It is believed that attention might advisably have been given to the more complete development of some of the fundamentals and in acquainting the reader with the need for readiness, on his part, for repeated future adjustment of his point of view in order that he may be prepared to keep pace with advances in soil physics, soil chemistry and soil microbiology. It will appear to some that more conscious recognition might advantageously have been made, also, of the limitations of our present knowledge and, on that account, of the frequently arbitrary means which are devised for the solution of some of the most urgent soils problems.

An unfortunate error has been overlooked in the discussion accompanying the development of the expression for the pH of water in Chapter IV. The denominator term in the first equation on page 100 may be regarded as constant and almost equal to the molar concentration, per liter, of water. It is not infinite, but in either case it can not be ignored.

The book is a distinctly useful one and will be well received by students and farmers desiring an introduction to soil science.

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TERMITES

Termites (Isoptera) from the Australian Region. By GERALD F. HILL. 479 pp. 24 plates. 353 figs. Australia: Council for Scientific and Industrial Research. 1942.

THOSE of us who take an interest in termites have followed the excellent work which Mr. Hill has done in Australia for many years past. In the book under review he has summarized the results of his investigation. The region is one which is particularly rich in species of termites. The Australian continent, alone, possesses no less than 140 species. As is well known,

it possesses the only living species of *Mastotermes*, the most primitive living termite and one which is responsible for a large amount of economic loss. Mr. Hill gives the means of identifying all the termites, which he recognizes from Australia, New Guinea and the islands south of the Equator, between 140° E and 170° W, a region which is of very great interest to us in this country at the present time. Although the book is primarily a description of species in technical terms, it should not be forgotten that this is ultimately one of the major bases of our knowledge of any group of animals, and where an entire fauna is redescribed so far as possible by one man on a uniform basis, the value of all separate descriptions is enhanced.

The book, however, is more than that since it includes a summary of whatever is known, all too frequently very little, of the biology of the various forms. It may, therefore, be considered as a foundation upon which much future detailed work will be laid. It is not surprising, with such a rich fauna hitherto described in fragments by many investigators, that detailed experimental work on the physiology of the species has not been widely undertaken before. We may hope to see a great increase in such work in the near future, now that the solution of the always troublesome problems of identification of material has been rendered as simple as may be.

In spite of the fact that the book is lithoprinted, its appearance is very pleasing and the illustrations are excellently drawn and well reproduced. I noticed only a few typographical errors, of no particular consequence.

CHARLES H. BLAKE

SPECIAL ARTICLES

ON THE MECHANISM OF INSULIN ACTION: OBSERVATIONS WITH RADIOACTIVE PHOSPHORUS

IN spite of the large amount of study that the subject has received, the mechanisms by which insulin brings about increased deposition of glycogen and oxidation of glucose in striated muscle are little better understood than when these effects were first observed. The participation of the phosphorus compounds in carbohydrate metabolism offers the hope that tracer studies with the radioactive isotope of this element (P^{32}) would cast some light on the matter. In this preliminary report are described some effects of insulin on phosphate metabolism in resting muscle, as determined by this technique; possible correlations of the findings on the intact animal with those obtained on cell-free extracts are discussed.

The injection of insulin into cats under pentobarbital anesthesia was found to result in an increased turnover rate of phosphocreatine P and of the two labile phosphate groups of adenosine triphosphate during glucose absorption, and no change in the rate of turnover of glucose-6-phosphate beyond that resulting from the administration of glucose alone.

Three groups of experiments were performed on 24-hour fasted animals. In each case, the muscles were analyzed 4 hours after the subcutaneous action of Na_2HPO_4 containing P^{32}. In the control group (8 animals) only the phosphate was given. A second group (4 animals) was given 50 ccm per kgm of 5 per cent. glucose solution intraperitoneally half an hour after the glucose. A third group (4 animals) was given glucose in the same way as the second group, followed half an hour later by a subcutaneous injection of 5 units of insulin per kgm.

The phosphorus compounds were separated from trichloroacetic acid filtrates and measurements of radioactivity made by methods similar to those previously described.[1] The data, given in Table 1, are expressed in terms of counts per minute per mgm of P, calculated to the basis of 10^6 counts per minute injected, per kgm body weight.

TABLE 1

TURNOVER RATES OF PHOSPHORUS COMPOUNDS IN RESTING MUSCLES OF CATS, AS INFLUENCED BY GLUCOSE AND INSULIN*

	Inorganic phosphate	Phospho-creatine	Adenosine triphosphate	Glucose-6-phosphate	Plasma inorganic phosphate
Group I Phosphate only	364 (224–470)	125 (64–182)	82 (50–117)	208 (114–298)	9460 (5300–14,400)
Group II Phosphate and Glucose	308 (212–460)	115 (67–210)	77 (64–106)	522 (402–665)	9475 (7150–14,200)
Group III Phosphate, glucose and insulin	325 (225–415)	317 (205–425)	189 (133–248)	482 (374–620)	6200 (4950–8800)

* All values are expressed in terms of counts per minute per mgm P, calculated to the basis of 10^6 counts per minute injected, per kgm body weight. Figures given are averages, with the range in parentheses.

It is apparent that the injection of insulin during glucose absorption results in an acceleration of the turnover rates of phosphocreatine and adenosine triphosphate, and that this effect is not seen in the absence of an external supply of insulin. It is quite

[1] Jacob Sacks and Charles H. Altshuler, *Am. Jour. Physiol.*, 137: 750, 1942.

possible that this increased turnover is associated with the increased oxidation of glucose that insulin produces in resting muscle. Such coupling of phosphorylation with oxidative reactions has been reported many times in cell-free extracts. In most of such studies the emphasis has been placed on adenosine triphosphate, but the present findings indicate that phosphocreatine is also involved. Obviously it is inadvisable to attempt any specific correlations between the observed changes in the intact animal and the vast number of reactions found in cell-free extracts. However, these results point strongly in the direction of such an association of phosphorylation with glucose oxidation in the resting metabolism of muscle, and indicate that insulin, by accelerating glucose oxidation, also accelerates these phosphorylation reactions.

With regard to glucose-6-phosphate, on the other hand, it is evident that the administration of glucose alone to the 24-hour fasted animal does produce an increased turnover which is not affected by an external supply of insulin. It remains for future study to determine whether the increased turnover evoked by glucose depends on the normal secretion of insulin.

Caution is necessary in evaluating the data on the glucose-6-phosphate in relation to the question of phosphorylation during glucose absorption. The presence of P^{32} in higher concentration in this substance than in the other organic phosphorus compounds shows that some phosphorylation of glucose does take place. However, in relation to the total probable glucose absorption, the amount of phosphorylation observed is rather small. This becomes evident on comparison of the P^{32} levels of glucose-6-phosphate and plasma inorganic phosphate. The average glucose-6-phosphate content of resting muscle does not exceed 10 mgm per cent., calculated as P, and there is no interchange of phosphate groups between this substance and phosphocreatine or adenosine triphosphate.[1] Therefore the transfer of 1 mgm per cent. of P across the cell membrane in the form of glucose-6-phosphate should raise the P^{32} level of this substance to at least 1,000 counts per minute per mgm P when the P^{32} of the plasma P is of the order of 10,000 counts per minute per mgm P. But the highest values obtained are only about half of this amount, indicating the transfer of about 3 mgm per cent. of glucose into the muscle in the form of glucose-6-phosphate. This holds even in the insulin experiments, when it would be anticipated that glycogen deposition and glucose oxidation are taking place at relatively high rates. If the glucose phosphate were dephosphorylated in the formation of glycogen, not only the glucose-6-phosphate but also the inorganic phosphate of the muscle should show higher P^{32} levels in the insulin experiments than in the other two groups. Two possible interpretations of the present data are: (1) that the absorption of glucose by the muscle fiber does not involve the entrance of a phosphate group into the cell, or (2) that glucose-6-phosphate is not involved in the principal mechanism of glucose absorption by resting muscle.

Summary. Insulin causes a marked increase in the turnover rates of phosphocreatine and adenosine triphosphate in resting muscle during glucose absorption, as determined with radioactive phosphorus, but does not cause any increase in turnover of glucose-6-phosphate beyond that produced by glucose itself.

The radioactive phosphorus used was supplied by the Department of Physics of the University of Michigan.

This work was supported by a grant from the John and Mary R. Markle Foundation.

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SULFONAMIDE DEPRESSION OF INORGANIC CATALYTIC ACTION[1]

AN anti-catalytic action has been urged as the fundamental mechanism of the antiseptic action of the sulfonamides, although it would probably be weaker than that of many other antiseptics. The evidence for this has been limited to catalysts in living microorganisms. This theory does not necessarily conflict with the competition-interference theory in which the utilization of para-aminobenzoic acid and other agents essential to bacterial growth is affected by sulfonamides, because metabolic functions are basically mediated by catalytic action. Depression of all catalysts by the sulfonamides would be expected to decrease metabolism and growth of microorganisms. Johnson[2] has reported that the activity of the catalyst luciferase is reduced by sulfonamides and a number of other chemically unrelated agents, which, however, possess in common a depressant pharmacological action, especially narcosis. Certain narcotics, alkaloids, antiseptics and toxic ions are known for their depressant actions on inorganic catalysts, which are wholly foreign to living microorganisms. Thus far, however, no test has been made for similar possible effects of the sulfonamides. If positive, this would help to establish a general anticatalytic action for these chemotherapeutic agents. This report presents positive results, demonstrated by us with three inorganic catalysts, namely, fullers' earth, platinum black and colloidal silver.

Methods: Santesson's[3] procedure for testing cata-

[1] From the Department of Pharmacology and Therapeutics, Stanford University School of Medicine, San Francisco, Calif.

[2] Johnson, SCIENCE, 95: 104, 1942.

[3] Santesson, *Skand. Arch. f. Physiol.*, 42: 129, 1922.

lytic liberation of oxygen from hydrogen peroxide *in vitro* was used. Quinine and a number of other protoplasmic poisons known to inhibit this catalytic action were used for checking the validity of results with the sulfonamides and other compounds. In each experiment there were results on oxygen liberation with the unpoisoned catalyst, as control, for comparison with results with a number of agents under the same conditions. The procedure was as follows: Into a small fermentation tube a weighed and constant amount (20 mgm or less) of the catalyst was placed. Next, a small, though constant, amount of the agent to be tested was added, except in the controls (usually 1 cc of a 1 per cent. solution, or less). Then, 1 cc of a 1 per cent. solution of hydrogen peroxide was added. Finally, the tube was filled with water, and quickly inverted into a slightly larger tube, also filled with water. As the oxygen was liberated it collected in the smaller tube and the height of the column of gas was measured by comparison with a millimeter scale.

Three different catalysts were used, namely fullers' earth, which caused a slow liberation of oxygen; platinum black, which caused a rapid, almost explosive, liberation; and colloidal silver (collargol), which had intermediate activity. All gave similar results, but fullers' earth was used in the vast majority of experiments, as the slow action prevented loss of liberated oxygen during manipulation of the tubes. The action was somewhat capricious and necessitated use of accurate quantities throughout for satisfactory results. For each agent tested, multiple trials were made, usually 10 or more. There was a general tendency for the gas formation in both test and control tubes to reach eventually the same volume, and, therefore, the tubes were read at various times before the total completion of catalytic action. When platinum black and collargol were used, the gas-measurements were made at the end of 5 minutes, or less; with fullers' earth, at the end of 24 hours.

Comparative Effects of Various Protoplasmic Poisons and Sulfonamides: Quinine sulfate, quinacrine hydrochloride, pamaquine naphthoate (suspension), acriflavine, sodium salicylate, carbarsone and sodium cyanide markedly reduced the liberation of oxygen, generally less than 50 per cent. of the control volume. Free acids (sulfuric, ascorbic, nicotinic and para-aminobenzoic) were also strongly inhibitory, and therefore all agents with an acid reaction were carefully neutralized before trial. Alkalis (hydroxide and bicarbonate of sodium) had no effect, or increased slightly the liberation of oxygen. Accordingly, the effects of sodium salicylate and sodium cyanide, which are alkaline, must have been due to the salicyl and cyanogen ions, respectively. The single exception to the general group of protoplasmic poisons was sodium fluoride, which increased markedly the liberation of oxygen with fullers' earth and collargol. However, fluoride reduced the activity of platinum black, about like quinine. Platinum black and collargol were affected like fullers' earth by all other agents tried.

Sulfanilamide and sulfaguanidine were less active as depressants than the most potent poisons tried as they reduced the volume of liberated oxygen only about 16 per cent. The other sulfonamides tried, sulfapyridine, sulfathiazole, sulfadiazine, sulfacetimide and sulamyd, were more active, the liberation of oxygen being reduced from 22 to 54 per cent., despite their lower solubility than sulfanilamide. The sodium salts of acetylsulfanilamide and of acetylsulfapyridine were less effective, causing about 20 per cent. reduction in oxygen liberation. The sodium salts of sulfanilamide, sulfapyridine, sulfathiazole and sulfadiazine generally produced weaker effects than the free compounds, *i.e.*, about 20 per cent. less. The depressant effects of the sulfonamides occurred on all the three inorganic catalysts and were consistent in individual group tests, but varied from group to group, the per cent. changes reported being medians. It appeared interesting to determine next the effects of so-called "inhibitors" of sulfonamide action on the anticatalytic effects of these and some other drugs.

Action of "Inhibitors" on Anticatalysts: This was determined with fullers' earth only. Neutralized solutions of para-aminobenzoic acid alone had practically no demonstrable effect on oxygen liberation. When sulfonamides were also present, or quinine, pamaquine or quinacrine, there was no interference with their anticatalytic actions. Neutralized nicotinic acid had a strong depressant action on oxygen liberation, which was practically not affected by the presence of sulfonamides or the quinine group.

Comment: These results place the sulfonamides in the group of anticatalysts affecting non-living catalytic systems. This agrees with the claims of others as to an anticatalytic action in microorganisms being fundamental to the antiseptic action of these agents. The mechanism of this anticatalytic action is uncertain, but may be a physico-chemical surface phenomenon. Compared with the quinine group of alkaloids and a number of other protoplasmic agents, the sulfonamides are weak depressants of catalytic action, which is consistent with their known action as systemic antiseptics. Para-aminobenzoic acid, nicotinic acid and the sulfonamides are non-competitive for the inorganic catalysts used, as the nutrient agents do not demonstrably inhibit the sulfonamide depression. Nor does the latter involve replacement of the nutrient agents, since these are absent in the inorganic catalyst, unless purposely added. This lack of antag-

onism of the para-aminobenzoic acid and nicotinic acid on sulfonamides in inorganic catalysts is a difference from the conception of the antagonism or competition in living systems. However, this may be more apparent than real, as there are well-known difficulties in reconciling the actions of these agents and their properties and the relationships of antagonisms which need not be considered here. Certainly, it is of more than passing interest that the sulfonamides can reduce inorganic catalytic actions like other antiseptics and poisons.

CONCLUSIONS

(1) The sulfonamides decrease the liberation of oxygen from hydrogen peroxide by such inorganic catalysts as fullers' earth, platinum black and collargol, but the depression is much weaker than that caused by quinine, pamaquine, quinacrine and a number of other protoplasmic poisons. This agrees with current theories of an anticatalytic action as being fundamental to the antiseptic action of these agents.

(2) Para-aminobenzoic acid and nicotinic acid and the sulfonamides are non-competitive, or not antagonistic to each other, on the inorganic catalysts used, a difference from their action on microorganisms.

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GROWTH STIMULATION BY AMMONIUM SULFAMATE IN LOW CONCENTRATION

IN laboratory experiments on the toxicity of ammonium sulfamate $NH_4O_3SNH_2$ for nut grass (*Cyperus rotundus* L.),[1] it was observed that the poisonous action of the salt was preceded by a marked increase in the number of plants during the first three days of the experiment. Indications of a growth-stimulating action have been discussed also in investigations of other herbicides, *e.g.*, the chlorate,[2] the sodium bromate[3] and the thiocyanate.[4] The latter one has already found application for hastening the germination of seeds and potatoes.

It seemed worth while to investigate the possible stimulating effect of the ammonium sulfamate. Duckweed (*Lemna minor*) was selected as a test plant as in former experiments[3] because the increase in the number of plants offered a convenient way of watching the effect of the compound. The plants (on the average 20) were kept in glass jars filled with two inches of soil and two liters of tap water. The number of plants was counted daily and expressed in per cent. of the initial number. The curves reproduced below give the average of all the experiments performed during several months.

Curves 1 and 2 represent the effects of so much ammonium sulfamate as to make the solution 0.01 and 0.005 molar with respect to this salt (Fig. 1). In both

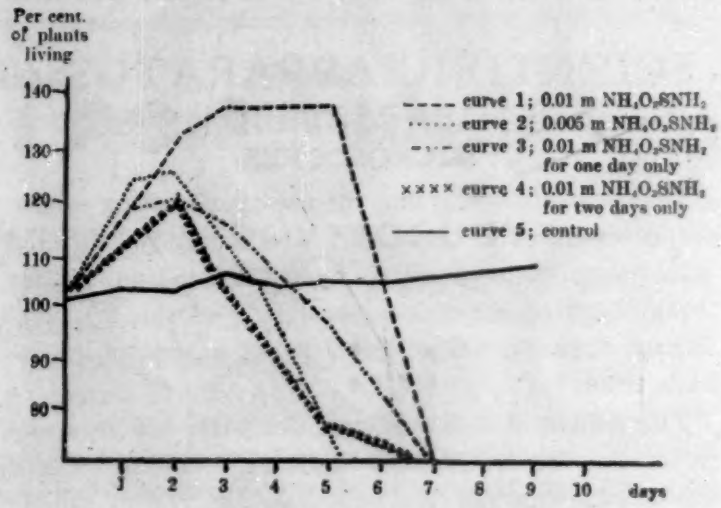

FIG. 1

cases the increase in number over the control experiments (curve 5) is very remarkable for the first 2 to 5 days, but then the poisonous action of the salt leads to a rapid and complete destruction of all the plants.

It seemed possible that a reduction of the time of action of the salt on plants might lead to a separation of the stimulating and the toxic effect. In further experiments the plants were therefore removed from the sulfamate-containing jar after a limited period of time and transferred to another one containing tap water and soil only. Curves 3 and 4 show that an action of the sulfamate for two- or one-day, respectively, reduced mainly the stimulating effect but did not alter appreciably the rate of poisoning. However, the killing of the plants could be avoided when the contact with the sulfamate was limited to five hours (curve 6, Fig. 2). The increase in the number of

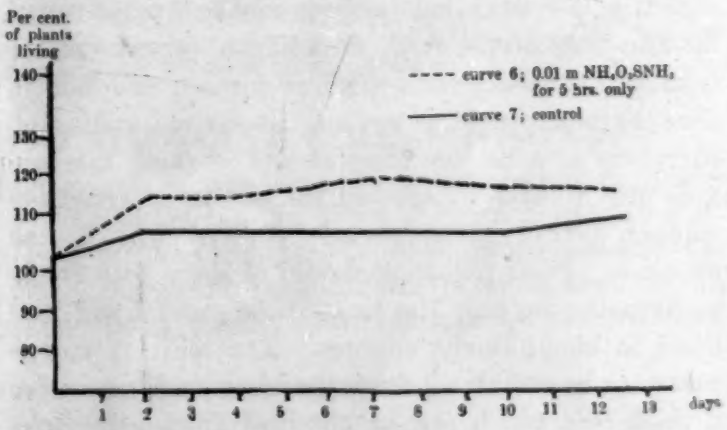

FIG. 2

plants was small under these circumstances, in fact only about one fourth of that obtained in the first experiment, but the rate of growth in the first two

[1] Fromm, *Ciencia y Técnica*, 1: 69, 1943.
[2] Shear, *Phytopathology*, 25: 440, 1935.
[3] Hessenland, Fromm and Saalmann, *Angew. Chem.*, 46: 577, 1933.
[4] Denny, *Biol. Abstracts*, No. 674, 1930.

days was twice that of the controls and thrice that of the controls for the first seven days, so that this stimulation appears to be well established.

There is not yet anything known as to the mechanism of this stimulation, but it seems of interest that the inorganic sulfamate causes here similar increases in growth as they were described recently by Lamanna[5] for low concentrations of sulfanilamide on bacteria.

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

A COOL LIGHT FOR DISSECTING MICROSCOPES

INVESTIGATORS who find the use of dissecting microscopes essential to their work are usually confronted with the problem of satisfactory illumination. After three years of extensive use, lights of the type described have proven superior to all others which we have tried.

The principle is simple and the parts are inexpensive. An automobile headlight bulb mounted in a small metal can (35 mm bulk load film can or a deep salve box) in which ventilating louvres have been cut serves as the source. This may be mounted on any convenient stand or on the microscope itself. Power is furnished by a transformer which delivers six volts and will carry up to two and one-half amperes of current. If intensity control is desired, a rheostat may be inserted in series with the primary coil of the transformer (in the input—110 volt—line). The important feature of the light is the lens system. It is composed of a rod of methyl methacrylate polymer (du Pont Lucite) $\frac{5}{8}$″ by 3″ or larger upon the ends of which a lens combination has been ground. The rod is mounted in the lamp housing so that the filament of the light is centered and thus serves to focus the source and at the same time to filter out nearly all the heat. Small pieces of Lucite may be obtained in the form of utility lights from drug and department stores or in rods from the manufacturer.

In order to concentrate the source of light upon the object, a bi-convex lens system can be ground upon the two ends of the rod. Grinding a curved surface is in reality easier than a plane surface and can be done by clamping the rod at the desired radius of curvature in a flexible support and working the surface into a curve by moving the end in an irregular manner over a plane surface covered with a fine abrasive. Final polishing should be done with rouge or Tripoli powder. The lens can be ground and polished in about thirty minutes. The radii of curvature may be calculated from the common formula for a thick lens which can be obtained from handbooks of physics and chemistry. Details of the assembly are apparent in Fig. 1.

For work on living material or material immersed in a saline solution, water or a solvent this light has proved most satisfactory since very little heat is transmitted to the object. Physiological processes are not upset, salines and solvents are not evaporated rapidly, and an intense spot of light is directed to the object. When water or saline solutions are used to cover the

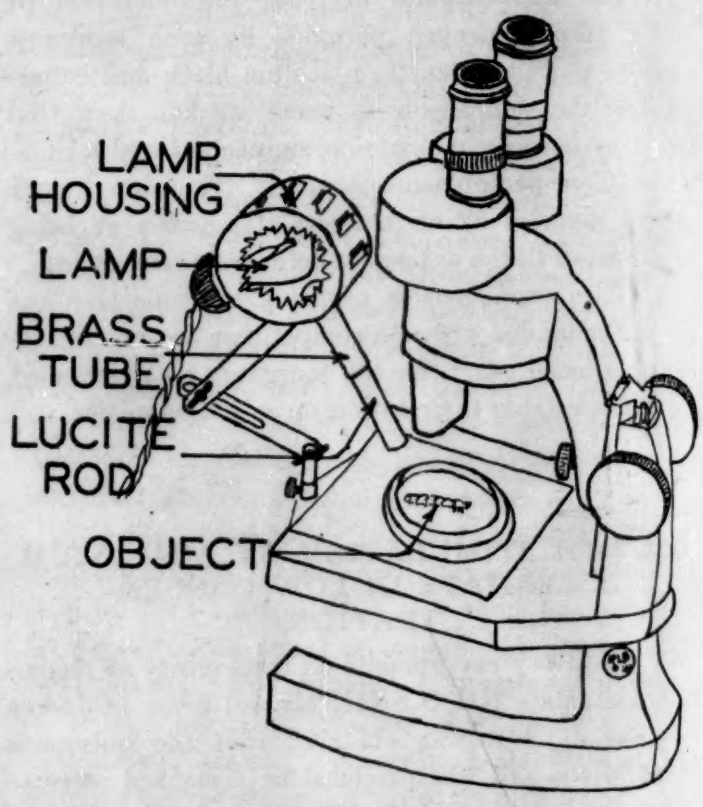

FIG. 1

object, undesirable surface reflections can be avoided by immersing the end of the rod. These features are unique with this light.

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DEPARTMENT OF ENTOMOLOGY,
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[5] Lamanna, SCIENCE, 95: 304, 1942.

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